Loads and Dynamics ARAC WG Report for 25.415 Ground Gust
18 June 2001
Harmonization (Category 3) and New Projects

1 - What is underlying safety issue to be addressed by the FAR/JAR?

CFR 14 Amendment 25-91 increased the ground gust velocity requirement for § 25.415 from 60 MPH (52 Knots) TAS to 65 KTAS. However based on several incidents that have occurred to aircraft on the United Kingdom register and at least one aircraft on the US register, it has been determined that the effects of control system flexibility can lead to internal loads greater than those corresponding to the hinge moments prescribed by § 25.415. Although damage from ground gusts may not be an immediate hazard, the rule is intended to prevent damage to the control system that may not be detected before take-off. The JAA Structures Study Group has developed a draft NPA 25C-284 in response to this issue.

The L&D HWG was assigned the task of harmonizing FAR and JAR 25.415 as a Fast Track Category 1 item. However the existence of the draft NPA 25C-284 and the safety issues addressed therein caused the L&D HWG to successfully petition for a change in the Fast rack Category to Category 3. Currently the rules § 25.391 through § 25.415 are convoluted and confusing and have lead to differing interpretations being utilized as the basis for compliance.

2 - What are the current FAR and JAR standards relative to this subject?

Current FAR text:

(a) The control system must be designed as follows for control surface loads due to ground gusts and for taxiing downwind:
  (1) The control system between the stops nearest the surfaces and the cockpit controls must be designed for loads corresponding to the limit hinge moment of paragraph (a)(2) of this section. These loads need not exceed -
  (i) The loads corresponding to the maximum pilot forces in 25.397(c) for any pilot alone or
  (ii) O.75 times these maximum loads for each pilot when the pilot forces are applied in the same direction
  (2) The control system stops nearest the surfaces , the control system locks and the parts of the system (if any) between these stops and locks and the control surface horns, must be designed for the limit hinge moments H, in foot pounds, obtained from the formula,

$H = .0034KV^2cS$, where__
V = 65 (wind speed in knots)

K = limit hinge moment factor for ground gusts derived in paragraph (b) of this section.
c = mean chord of the control surface aft of the hinge line (ft);
S = area of the control surface aft of the hinge line (sq ft);

(b) The limit hinge moment factor K for ground gusts must be derived as follows:

	Surface	*K*	Position of controls
	(a) Aileron ----------	0.75	Control column locked or lashed in mid-position.
	(b) Aileron ---------- (c) Elevator---------- (d) Elevator---------- (e) Rudder---------- (f) Rudder----------	*±0.50 *±0.75 *±0.75 0.75 0.75	Ailerons at full throw. (c) Elevator full down. (d) Elevator full up. (e) Rudder in neutral. (f) Rudder at full throw.

* A positive value of *K* indicates a moment tending to depress the surface, while a negative value of *K* indicates a moment tending to raise the surface.

Current JAR text (As of Change 15):

Same as above FAR text.

2a – If no FAR or JAR standard exists, what means have been used to ensure this safety issue is addressed?

Not applicable.

3 - What are the differences in the FAA and JAA standards or policy and what do these differences result in?

There are no differences in current standards. It is however a JAA policy that for aircraft where the dynamic response of control systems may be significant for ground gusts, the dynamic effects of control systems be taken into account. The JAA requires consideration of the control systems "locked" while moored and "unlocked" when taxing downwind.

4 - What, if any, are the differences in the current means of compliance?

Discussed in item 3.

5 – What is the proposed action?

Develop an NPRM with the following requirements:

§ 25.391 Control surface loads: general.

The control surfaces must be designed for the limit loads resulting from the flight conditions in §§ 25.331, 25.341(a) and (b), 25.349 and 25.351 ~~and the ground gust conditions in Sec. 25.415~~, considering the requirements for -

(a) Loads parallel to hinge line, in § 25.393;
(b) Pilot effort effects, in § 25.397;
(c) Trim tab effects, in § 25.407;
(d) Unsymmetrical loads, in § 25.427; and
(e) Auxiliary aerodynamic surfaces, in § 25.445.

§ 25.395 Control Systems

(a) (retain current text)
(b) The system limit loads <u>of paragraph (a)</u>~~, except the loads resulting from ground gusts,~~ need not exceed the loads that can be produced by the pilot (or pilots) and by automatic or power devices operating the controls.
(c) (retain current text)

§ 25.415 Ground gust conditions.

(a) The flight control systems and surfaces must be designed for the limit loads generated when the aircraft is subjected to a horizontal 65 knots ground gust from any direction, while taxiing with the controls locked and unlocked and while parked with the controls locked.

(b) The control system and surface loads due to ground gust may be assumed to be static loads and the hinge moments H, in foot pounds, must be computed from the formula,

$H=K\ 1/2\rho_o V_{fps}^2 cS$

where:
K = hinge moment factor for ground gusts derived in paragraph (c) of this paragraph
ρ_o = density of air at sea level = .0023769 (slugs/ft^3) = .0023769 (lb-sec^2/ ft$^{4)}$
V = 65 knots = 109.71 fps relative to the aircraft
S = area of the control surface aft of the hinge line (ft^2)
c = mean aerodynamic chord of the control surface aft of the hinge line (ft)

(c) The hinge moment factor K for ground gusts must be taken from the following table:

	Surface	*K*	Position of controls
	(a) Aileron ----------	0.75	Control column locked or lashed in mid-position.
	(b) Aileron ---------- (c) Elevator---------- (d) Elevator---------- (e) Rudder---------- (f) Rudder----------	*±0.50 *±0.75 *±0.75 0.75 0.75	Ailerons at full throw. (c) Elevator full down. (d) Elevator full up. (e) Rudder in neutral. (f) Rudder at full throw.

* A positive value of *K* indicates a moment tending to depress the surface, while a negative value of *K* indicates a moment tending to raise the surface.

(d) The computed hinge moment of paragraph (b) must be used to determine the limit loads due to ground gust conditions for the control surface. A 1.25 factor on the computed hinge moments must be used in calculating limit control system loads.

(e) Where control system flexibility is such that the rate of load application in the ground gust conditions might produce transient stresses appreciably higher than those corresponding to static loads, in the absence of a rational analysis an additional factor of 1.6 must be applied to the control system loads of paragraph (d) to obtain limit loads. If a rational analysis is used, the additional factor must not be less than 1.20.

(f) For the condition of the control locks engaged, the control surfaces, the control system locks and the parts of the control systems (if any) between the surfaces and the locks must be designed to the respective resultant limit loads. Where control locks are not provided then the control surfaces, the control system stops nearest the surfaces and the parts of the control systems (if any) between the surfaces and the stops must be designed to the resultant limit loads. If the control system design is such as to allow any part of the control system to impact with the stops due to flexibility, then the resultant impact loads must be taken into account in deriving the limit loads due to ground gust.

(g) For the condition of taxiing with the control locks disengaged, the following apply:

(1) The control surfaces, the control system stops nearest the surfaces and the parts of the control systems (if any) between the surfaces and the stops must be designed to the resultant limit loads.

(2) The parts of the control systems between the stops nearest the surfaces and the cockpit controls must be designed to the resultant limit loads, except that the parts of the control system where loads are eventually reacted by the pilot need not exceed:

(i) The loads corresponding to the maximum pilot loads in § 25.397 (c) for each pilot alone; or

(ii) 0.75 times these maximum loads for each pilot when the pilot forces are applied in the same direction.

For each proposed change from the existing standard, answer the following questions:

6 - What should the harmonized standard be?

See question 5.

7 - How does this proposed standard address the underlying safety issue (identified under #1)?

An improved standard has been developed that removes ambiguities in the current regulations and also accounts for dynamic affects by requiring the simple use of factors that are applied to the loads. An additional factor is required for systems where dynamic effects may be significant. The approach is simple and will lead to consistent design requirements.

8 - Relative to the current FAR, does the proposed standard increase, decrease, or maintain the same level of safety? Explain.

Current level of safety is increased due to the elimination of confusing requirements and by requiring higher control system and control surface design loads requirements for ground gust where it is appropriate.

9 - Relative to current industry practice, does the proposed standard increase, decrease, or maintain the same level of safety? Explain.

Increases the level of safety. Many manufacturers have designed their control systems to account for the dynamic effects for ground gust. However such analyses are very complex and lead to a wide range of possible results. The proposed changes are based upon factors that are applied to static analyses that will result in more reliable and uniform certification compliance. Dynamic analysis is still allowed as an option. However, when dynamic analysis is used minimum increases in loads due to dynamic effects are specified as a floor design level.

10 - What other options have been considered and why were they not selected?

The JAA has required that the dynamic effects be accounted for by analysis. Due to the difficulties in doing such analysis, the HWG believes that the proposed standard is more appropriate.
The L&DHWG reviewed the issue of potential control system damage during aircraft ground operations in ground gust conditions. An issue had been raised regarding the potential for control system damage due to impact of the surfaces with the stop with the gust locks disengaged and with the control system not constrained by the pilot.

The concern is for reversible systems such as manual systems that do not have a significant amount of damping.

The following conclusions have been reached:

1. The design load level has been increased by a factor of at least 2.5 relative to earlier design requirements for systems with significant flexibility.

2. The proposed rule addresses the effect of control surface impact with the control stops for flexible systems.

3. The L&DHWG does not feel that it is reasonable to operate an aircraft with manual control systems in design ground gust conditions with the pilot not constraining the control systems. This is supported by the FAA Flying Handbook FAA-H-8083-3 Chapter 2 for Ground Operations.

4. Some aircraft have operational procedures that require the gust lock to remain engaged until shortly before takeoff.

5. The L&D HWG is not aware of conclusive evidence of failure of the control systems when the pilot is not constraining the flight controls.

6. Therefore the L&DHWG believes that the requirements that have been developed for the instance where the pilot constrains the flight controls are adequate.

7. The L&DHWG recommends that the TAEIG consider the need for additional operational procedures or the development of pilot informative material regarding the need for constraint of the flight controls during ground operations.

11 - Who would be affected by the proposed change?

Airplane manufacturers.

12 - To ensure harmonization, what current advisory material (e.g., ACJ, AMJ, AC, policy letters) needs to be included in the rule text or preamble?

A new ACJ is recommended based upon the draft AC per below.

13 - Is existing FAA advisory material adequate? If not, what advisory material should be adopted?

There is no existing FAA advisory material. A draft AC 25.415-1 , as attached, is proposed along with a corresponding ACJ.

14 - How does the proposed standard compare to the current ICAO standard?

The current ICAO standard has no specific criteria for ground gust analysis.

15 - Does the proposed standard affect other HWG's?

No.

16 - What is the cost impact of complying with the proposed standard?

Economic analysis still to be done but it is expected to be small in comparison to standard industry practice.

17. - If advisory or interpretive material is to be submitted, document the advisory or interpretive guidelines. If disagreement exists, document the disagreement.

Draft Advisory Circular AC 25.415-1 is submitted.

18. - Does the HWG wish to answer any supplementary questions specific to this project?

Not at this time.

19. – Does the HWG want to review the draft NPRM at "Phase 4" prior to publication in the Federal Register?

Yes

20. – In light of the information provided in this report, does the HWG consider that the "Fast Track" process is appropriate for this rulemaking project, or is the project too complex or controversial for the Fast Track Process? Explain.

It is appropriate for the "Fast Track" process.

[4910-13]

DEPARTMENT OF TRANSPORTATION

Federal Aviation Administration

14 CFR Part 25

[Docket No. ; Notice No.]

RIN: 2120-

Ground Gust Conditions.

AGENCY: Federal Aviation Administration (FAA), DOT.

ACTION: Notice of proposed rulemaking (NPRM).

SUMMARY: The Federal Aviation Administration proposes to amend the airworthiness standards for transport category airplanes in regard to ground gust design conditions for control systems and surfaces. The proposed amendment would revise the regulations to require an additional multiplying factor on design loads to account for dynamic loading conditions. Several near accidents have occurred as a result of the dynamic effects of ground gusts conditions which have caused damage to control systems that was not detected before take-off. This proposal is based on a recommendation by the Aviation Rulemaking Advisory Committee (ARAC) and is intended to ensure that control systems and surfaces can withstand the ground gust conditions expected in service. The Joint Aviation Authorities (JAA) of Europe are considering a similar proposal to amend the Joint Aviation Requirements (JAR-25). Adopting this proposal would maintain similar requirements between the airworthiness standards of the U.S. and the Joint Aviation Requirements of Europe.

DATES: Send your comments on or before [Insert date 60 days after date of publication in the Federal Register.]

ADDRESSES:

Comments: Address your comments to Dockets Management System, U.S. Department of Transportation Dockets, Room Plaza 401, 400 Seventh Street SW., Washington, DC 20590-0001. You must identify the docket number _____ at the beginning of your comments, and you should submit two copies of your comments. If you wish to receive confirmation that the FAA has received your comments, please include a self-addressed, stamped postcard on which the following statement is made: "Comments to Docket No. _____." We will date-stamp the postcard and mail it back to you.

You also may submit comments electronically to the following Internet address: http://dms.dot.gov.

Public Docket: You may review the public docket containing comments to this proposed regulation at the Department of Transportation Dockets Office, located on the plaza level of the Nassif Building at the above address. You may review the public docket in person at this address between 9:00 a.m. and 5:00 p.m., Monday through Friday, except Federal holidays. Also, you may review the public dockets on the Internet at http://dms.dot.gov.

Information Docket: In addition, the FAA is maintaining an "information docket" of comments in the Transport Airplane Directorate, FAA, Aircraft Certification Service, Program Management Branch (ANM-114), 1601 Lind Avenue SW., Renton, Washington 98055-4056. You may review the information docket in person at this address between 7:30 a.m. and 4:00 p.m., Monday through Friday, except Federal holidays.

FOR FURTHER INFORMATION CONTACT: James Haynes, FAA, Airframe and Cabin Safety Branch (ANM-115), Transport Airplane Directorate, Aircraft Certification Service, 1601 Lind Ave S.W., Renton, Washington 98055-4056; telephone (425) 227-2131; facsimile (425) 227-1320; e-mail: jim.haynes@faa.gov.

SUPPLEMENTARY INFORMATION:

How Do I Submit Comments to this NPRM?

Interested persons are invited to participate in the making of the proposed action by submitting such written data, views, or arguments, as they may desire. Comments relating to the environmental, energy, federalism, or economic impact that might result from adopting the proposals in this document are also invited. Substantive comments should be accompanied by cost estimates. Comments must identify the regulatory docket number and be submitted in duplicate to the DOT Rules Docket address specified above.

All comments received, as well as a report summarizing each substantive public contact with FAA personnel concerning this proposed rulemaking, will be filed in the docket. The docket is available for public inspection before and after the comment closing date.

We will consider all comments received on or before the closing date before taking action on this proposed rulemaking. Comments filed late will be considered as far as possible without incurring expense or delay. The proposals in this document may be changed in light of the comments received.

How Can I Obtain a Copy of this NPRM?

You may download an electronic copy of this document using a modem and suitable communications software from the FAA regulations section of the Fedworld electronic bulletin board service (telephone: 703-321-3339); the Government Printing Office (GPO)'s electronic bulletin board service (telephone: 202-512-1661); or, if applicable, the FAA's Aviation Rulemaking Advisory Committee bulletin board service (telephone: 800-322-2722 or 202-267-5948).

Internet users may access recently published rulemaking documents at the FAA's web page at http://www.faa.gov/avr/arm/nprm/nprm.htm or the GPO's web page at http://www.access.gpo.gov/nara.

Any person may obtain a copy of this document by submitting a request to the Federal Aviation Administration, Office of Rulemaking, ARM-1, and 800 Independence Avenue, SW., Washington, DC 20591; or by calling 202- 267-9680. Communications must identify the docket number of this NPRM.

Any person interested in being placed on the mailing list for future rulemaking documents should request from the above office a copy of Advisory Circular 11-2A, "Notice of Proposed Rulemaking Distribution System," which describes the application procedure.

What Are the Relevant Airworthiness Standards in the United States?

In the United States, the airworthiness standards for type certification of transport category airplanes are contained in 14 Code of Federal Regulations (CFR) part 25, commonly referred to as the Federal Aviation Regulations (FAR). Manufacturers of transport category airplanes must show that each airplane they produce of a different type design complies with the appropriate part 25 standards. These standards apply to:

- airplanes manufactured within the U.S. for use by U.S.-registered operators, and
- airplanes manufactured in other countries and imported to the U.S. under a bilateral airworthiness agreement.

What Are the Relevant Airworthiness Standards in Europe?

In Europe, the airworthiness standards for type certification of transport category airplanes are contained in Joint Aviation Requirements (JAR)-25, which are based on part 25. These were developed by the Joint Aviation Authorities (JAA) of Europe to provide a common set of airworthiness standards within the European aviation community. Twenty-three European countries accept airplanes type certificated to the JAR-25 standards, including airplanes manufactured in the U.S. that are type certificated to JAR-25 standards for export to Europe.

What is "Harmonization" and How Did it Start?

Although part 25 and JAR-25 are very similar, they are not identical in every respect. When airplanes are type certificated to both sets of standards, the differences between part 25 and JAR-25 can result in substantial additional costs to manufacturers and operators. These additional costs, however, frequently do not bring about an increase in safety. In many cases, part 25 and JAR-25 may contain different requirements to accomplish the same safety intent. Consequently, manufacturers are usually burdened with meeting the requirements of both sets of standards, although the level of safety is not increased correspondingly.

Recognizing that a common set of standards would not only benefit the aviation industry economically, but also maintain the necessary high level of safety, the FAA and the JAA began an effort in 1988 to "harmonize" their respective aviation standards. The goal of the harmonization effort is to ensure that:

- where possible, standards do not require domestic and foreign parties to manufacture or operate to different standards for each country involved; and
- the standards adopted are mutually acceptable to the FAA and the foreign aviation authorities.

Both the FAA and the JAA consider "harmonization" of the two sets of standards a high priority.

What is ARAC and What Role Does it Play in Harmonization?

After initiating the first steps towards harmonization, the FAA and JAA soon realized that traditional methods of rulemaking and accommodating different administrative procedures was neither sufficient nor adequate to make appreciable progress towards fulfilling the goal of harmonization. The FAA then identified the Aviation Rulemaking Advisory Committee (ARAC) as an ideal vehicle for assisting in

resolving harmonization issues, and, in 1992, the FAA tasked ARAC to undertake the entire harmonization effort.

The FAA had formally established ARAC in 1991(56 FR 2190, January 22, 1991), to provide advice and recommendations concerning the full range of the FAA's safety-related rulemaking activity. The FAA sought this advice to develop better rules in less overall time and using fewer FAA resources than previously needed. The committee provides the FAA firsthand information and insight from interested parties regarding potential new rules or revisions of existing rules.

There are 64 member organizations on the committee, representing a wide range of interests within the aviation community. Meetings of the committee are open to the public, except as authorized by section 10(d) of the Federal Advisory Committee Act.

The ARAC establishes working groups to develop recommendations for resolving specific airworthiness issues. Tasks assigned to working groups are published in the Federal Register. Although working group meetings are not generally open to the public, the FAA solicits participation in working groups from interested members of the public who possess knowledge or experience in the task areas. Working groups report directly to the ARAC, and the ARAC must accept a working group proposal before ARAC presents the proposal to the FAA as an advisory committee recommendation.

The activities of the ARAC will not, however, circumvent the public rulemaking procedures; nor is the FAA limited to the rule language "recommended" by ARAC. If the FAA accepts an ARAC recommendation, the agency proceeds with the normal public rulemaking procedures. Any ARAC participation in a rulemaking package is fully disclosed in the public docket.

What is the Status of the Harmonization Effort Today?

Despite the work that ARAC has undertaken to address harmonization, there remain a large number of regulatory differences between part 25 and JAR-25. The current

harmonization process is extremely costly and time-consuming for industry, the FAA, and the JAA. Industry has expressed a strong desire to conclude the harmonization program as quickly as possible to alleviate the drain on their resources and to finally establish one acceptable set of standards.

Recently, representatives of the aviation industry [including Aerospace Industries Association of America, Inc. (AIA), General Aviation Manufacturers Association (GAMA), and European Association of Aerospace Industries (AECMA)] proposed an accelerated process to reach harmonization. These representatives recommended that the FAA and JAA harmonize differences between parallel part 25 and JAR-25 standards by accepting the more "stringent" of the two standards. "Stringent," in this case, indicates the relative higher level of safety, or greater applicability to modern technology, between a part 25 standard and the parallel JAR-25 standard.

Aviation industry groups further refined their proposed process by suggesting that the 42 part 25 standards that have already been tasked to ARAC for harmonization be divided into three categories:

Category 1: Envelope – For these standards, parallel part 25 and JAR-25 standards would be compared, and harmonization would be reached by accepting the more stringent of the two standards. In some cases, it may be necessary to incorporate parts of both the part 25 and JAR standard to achieve the final, more stringent standard. (This may necessitate that each authority revises its current standard to incorporate more stringent provisions of the other.).

Category 2: Completed or near complete – For these standards, ARAC has reached, or has nearly reached, technical agreement or consensus on the new wording of the proposed harmonized standards.

Category 3: Harmonize – For these standards, ARAC is not near technical agreement on harmonization, and the parallel part 25 and JAR-25 standards cannot be

"enveloped" (as described under Category 1) for reasons of safety or unacceptability. A standard developed under Category 3 would be mutually acceptable to the FAA and JAA, with a consistent means of compliance.

What is the "Fast Track Harmonization Program"?

In light of the general agreement among the affected industries and authorities to expedite the harmonization program, and a willingness to consider "enveloping" of parallel standards, the FAA and JAA in March 1999 agreed upon a method to achieve these goals. This method, which the FAA has titled "The Fast Track Harmonization Program," is aimed at expediting the rulemaking process for harmonizing not only the 42 standards that are currently tasked to ARAC for harmonization, but approximately 80 additional standards for part 25 airplanes.

The FAA initiated the Fast Track program on November 26, 1999 (64 FR 66522), by re-tasking ARAC to accomplish the following:

- Review a list of part 25/JAR-25 standards (approximately 120 parallel pairs) identified by industry, FAA, and JAA as having differences that should be harmonized in order to establish one single set of standards that represent the highest level of safety.
- Identify changes necessary to the standards to harmonize part 25 and JAR-25.
- Submit to the FAA a technical report on each standard and recommend what the requirements of the harmonized standard should be.

The FAA then considers the recommendations submitted by ARAC and initiates rulemaking action, as appropriate, based on those recommendations.

As implemented, the Fast Track program achieves its aims by:

- considering the fundamentals of the industry proposals,
- defining a process for expeditiously adopting the harmonized requirements,

- maintaining an emphasis on using ARAC in making a group decision on the harmonization proposal, and
- incorporating an improved ARAC rulemaking process that does not overburden the FAA and industry due to additional workload.

DISCUSSION OF THE PROPOSAL

How Does This Proposed Regulation Relate to "Fast Track"?

This proposed regulation results from the recommendations of ARAC submitted under the FAA's Fast Track Harmonization Program. Although the existing standards for § 25.415 "Ground gust conditions" are identical between FAR and JAR, the Joint Aviation Authorities has raised a safety issue as a result of some near accidents in Europe and they have been in the process of preparing a notice of proposed rulemaking that would improve the standard. It has also been recent JAA policy to request manufacturers to address these safety concerns during certification. Since this has created a difference in practice, this effort was included as part of the fast track program (category 3) in order to ensure a harmonized proposal would be achieved to address the safety concerns. In this notice, the FAA proposes to amend § 25.415, concerning ground gust conditions. The JAA plans a similar revision to the JAR.

What is the Underlying Safety Issue Addressed by the Current Standards?

The current standard is intended to protect the airplane flight control system from damage due to ground winds and gusts. Although damage from ground gusts may not be an immediate hazard, the rule is intended to prevent damage to the control system that may not be detected before take-off.

The current airworthiness standards contained in 14 CFR part 25 require that control systems and surfaces be designed for ground gusts and taxiing downwind. This implies two conditions. One in which the airplane is parked and unattended with gust

locks (if applicable) engaged, and the other, a taxi condition with the gust locks disengaged with the controls system powered (if applicable) and/or restrained by the pilot.

The requirement to consider the effects of ground gusts has been applied to transport airplane since 1950. The purpose of the requirement has been to protect the flight control system from excessive peak ground wind loads while the airplane is parked or while taxiing downwind. Although damage by ground gusts may not be an immediate hazard, the rule is intended to prevent damage to the control systems that may go unnoticed until the airplane is airborne.

For developing the original regulation, the control surface load distribution was considered to be triangular with the peak at the trailing edge representing reversed flow over the control surface. This assumption, along with assumptions about the wind approach angle and typical control surface geometries were developed into a table of hinge moment factors and set forth in the regulation. These hinge moment factors have been carried forward to the existing table in § 25.415. The maximum design wind speed was originally set at a maximum of 88 feet per second (52 knots) under the presumption that higher speeds were predictable conditions and the aircraft owner could take additional precautions (such as sheltering, additional tiedowns, or external bracing) beyond engaging the standard gust locks.

Amendment 25-91 (62 FR 40704) incorporated a new condition into the FAR for jacking and tie down loads which was similar to the existing Joint Aviation Requirement in paragraph 25.519. Those conditions required consideration of the airplane in a moored or jacked condition in peak wind speeds up to 65 knots. In order to be consistent in the treatment of ground winds, section 25.415, concerning ground gust conditions on control surfaces, was increased to 65 knots.

What are the Current JAR-25 and 14 CFR Standards?

The current texts of 14 CFR § 25.415 (amendment 25-91) and JAR-25 (change 15) are essentially identical:

25.415 Ground gust conditions.

(a) The control system must be designed as follows for control surface loads due to ground gusts and taxiing downwind:

(1) The control system between the stops nearest the surfaces and the cockpit controls must be designed for loads corresponding to the limit hinge moments H of paragraph (a)(2) of this section. These loads need not exceed--

(i) The loads corresponding to the maximum pilot loads in Sec. 25.397(c) for each pilot alone; or

(ii) 0.75 times these maximum loads for each pilot when the pilot forces are applied in the same direction.

(2) The control system stops nearest the surfaces, the control system locks, and the parts of the systems (if any) between these stops and locks and the control surface horns, must be designed for limit hinge moments, H, in foot pounds, obtained from the formula,

$H = .0034KV^2cS$, where___

V = 65 (wind speed in knots)

K = limit hinge moment factor for ground gusts derived in paragraph (b) of this section.

c = mean chord of the control surface aft of the hinge line (ft);

S = area of the control surface aft of the hinge line (sq ft);]

(b) The limit hinge moment factor K for ground gusts must be derived as follows:

Surface	K	Position of controls
(a) Aileron ----------	0.75	Control column locked or lashed in mid-position.
(b) Aileron ----------	*±0.50	Ailerons at full throw.
(c) Elevator----------	*±0.75	(c) Elevator full down.
(d) Elevator----------	*±0.75	(d) Elevator full up.
(e) Rudder----------	0.75	(e) Rudder in neutral.
(f) Rudder----------	0.75	(f) Rudder at full throw.

*A positive value of K indicates a moment tending to depress the surface, while a negative value of K indicates a moment tending to raise the surface.

How Have the Standards Been Applied?

Most of the experience in complying with the requirement are for airplanes with certification bases prior to amendment 25-91 (or JAR Change 15) so they were required to be designs to a speed of 52 knots rather than the existing 65 knots. The requirement has been applied as a static "steady" load condition to develop loads on the control surfaces, and loads in the control system between the pilots controls and the surface. Two conditions are considered, one with the aircraft parked and unattended with any available gust locks engaged, and the other with the aircraft taxiing with controls unlocked and restrained by the pilot, or control system power, or both. Section 25.391 "Control System Loads", requires an additional multiplying factor of 1.25 on the control system loads due to the control surface aerodynamic hinge moments but this regulation is confusing as to its applicability to the hinge moments derived for ground gusts and many manufacturers have not used this additional multiplying factor for the ground gust condition.

Why is a Revision to the Current Standards Needed?

The ground gust requirement was never intended to completely protect the airplane against all possible ground wind conditions that may occur. Wind conditions with

gusts in excess of the original design speed of 52 knots are relatively common around the world, however, they are considered to be reasonably predictable and the airplane operator has been expected to take additional precautions to protect the airplane if necessary. As airplanes have became larger, and operations more demanding, airplanes have become more difficult and inconvenient to protect in service and the need for higher ground gust design speeds has become evident. The speeds were increased to 65 knots in amendment 25-91 and that speed was derived from an existing design speed for ground wind conditions for airplanes that were tied down or on jacks.

Several incidents that have occurred to aircraft on the United Kingdom register and at least one aircraft on the US register where the aircraft sustained severe ground gust damage to the flight control system which went undetected until after takeoff. These incidents occurred on airplanes with unpowered mechanical controls with significant flexibility between the contol surface and the gust locking devices. This flexibility allows dynamic loads, well in excess of the static design gust loads, to occur.

Since amendment 25-91 has already raised the requirement from 52 knots to 65 knots (a 56 percent increase in design load) a considerable improvement in the resistance to ground gusts has already been achieved. There remains a need for clarification to ensure the application of the existing 1.25 factor in section 25.391 for the the ground gust condition and to provide additional design criteria for those airplanes which are susceptible to dynamic load amplification because of the control system and gust lock configuration.

What Is the Proposed Action and How Does It Address the Underlying Safety Issue?

This proposal would revise § 25.415 to stand alone in regard to the required multiplying factors and provide and additional multiplying factor to account for dynamic amplification. The design conditions would be set forth as two design cases; one with gust locks engaged and another as a taxiing case with the gust locks disengaged but

controls restrained by the pilot and/or powered system. The 1.25 factor would apply to the design hinge moments to obtain static limit loads for the design of the control system. A further multiplying factor of 1.6 (total multiplying factor of 2.0) would be applied for those parts of the control system where dynamic effects could be significant. These actions should eliminate any confusion as to the required multiplying factors and the net effect (including the speed increase resulting from amendment 25-91 and use of the 1.25 factor) over the past practices could be on the order of a 95 percent increase in the static ground gust design loads for the control system. For those parts of the control systems where dynamic amplification is of concern a total load increase of over 200 percent in the required design load may be realized along with a coresponding increase in strength. These load levels should be sufficient to account for the expected ground gust loads that are likely to occur in operation.

These changes would provide the greatest affect on mechanical, unpowered, control systems which have shown the greatest susceptability to damage. Powered control system normally possess natural protection from ground gusts by means of their hydraulic actuators.

What Changes Would Be Made to the Current 14 CFR

Sections 25.391 and 25.395 would be revised to eliminate any reference to ground gust conditions and section 25.415 would stand on its own in regard to the design multiplying factors. Section 25.415 would include the 1.25 multiplying factor currently contained in section 25.395. An additional multiplying factor of 1.6 would be required for parts of the control system where dynamic effects are expected to be significant. The rule would be organized to clarify the cases to be considered and to identify the components and parts of the control system and surface to which each of the conditions apply.

The JAA plans parallel changes to JAR-25.

Is Existing FAA Advisory Material Adequate?

The FAA is preparing to issue a new proposed Advisory Circular 25.415-1, "Ground gust conditions," to describe a means of compliance with the proposed regulation, which would meet the intended level of safety and promote consistent and effective application of the proposed revised standards. Public comments concerning the proposed AC are invited by separate notice published elsewhere in this issue of the Federal Register

REGULATORY ANALYSES AND ASSESSMENTS

Paperwork Reduction Act

In accordance with the Paperwork Reduction Act of 1995 [44 U.S.C. 3507(d)], the FAA had determined there are no requirements for information collection associated with this proposed rule.

Compatibility with ICAO Standards

In keeping with U.S. obligations under the Convention on International Civil Aviation, it is FAA policy to comply with International Civil Aviation Organization (ICAO) Standards and Recommended Practices to the maximum extent practicable. The FAA determined that there are no ICAO Standards and Recommended Practices that correspond to this proposed regulation.

Regulatory Evaluation Summary

Changes to Federal regulations must undergo several economic analyses. First, Executive Order 12866 directs that each Federal agency shall propose or adopt a regulation only upon a reasoned determination that the benefits of the intended regulation justify its costs. Second, the Regulatory Flexibility Act of 1980 requires agencies to analyze the economic effect of regulatory changes on small entities. Third, the Office of Management and Budget directs agencies to assess the effects of regulatory changes on international trade. And fourth, the Unfunded Mandates Reform Act of 1995 (Pub. L.

104-4) requires agencies to prepare a written assessment of the cots, benefits, and other effects of proposed or final rules that include a Federal mandate likely to result in the expenditure by State, local, or tribal governments, in the aggregate, or by the private sector, of $100 million or more annually (adjusted for inflation).

In conducting these analyses, the FAA has determined that this proposed rule: (1) would generate benefits that justify its costs and would not be "a significant regulatory action" as defined in section 3(f) of Executive Order 12866 and, therefore, is not subject to review by the Office of Management and Budget; (2) would not have a significant impact on a substantial number of small entities; (3) would not constitute a barrier to international trade; and (4) would not contain a significant intergovernmental or private sector mandate. These analyses, available in the docket, are summarized below. The FAA invites the public to provide comments and supporting data on the assumptions made in this evaluation. All comments received will be considered in the final regulatory evaluation.

Initial Regulatory Flexibility Determination

The Regulatory Flexibility Act of 1980 (RFA) establishes "as a principle of regulatory issuance that agencies shall endeavor, consistent with the objective of the rule and of applicable statutes, to fit regulatory and informational requirements to the scale of the business, organizations, and governmental jurisdictions subject to regulation." To achieve that principle, the Act requires agencies to solicit and consider flexible regulatory proposals and to explain the rationale for their actions. The Act covers a wide-range of small entities, including small businesses, not-for-profit organizations, and small governmental jurisdictions.

Agencies must perform a review to determine whether a proposed rule will have a significant economic impact on a substantial number of small entities. If the determination

is that it will, the agency must prepare a regulatory flexibility analysis as described in the Act.

However, if an agency determines that a proposed or final rule is not expected to have a significant economic impact on a substantial number of small entities, section 605(b) of the 1980 Act provides that the head of the agency may so certify and a regulatory flexibility analysis is not required. The certification must include a statement providing the factual basis for this determination, and the reasoning should be clear.

[APO to add economic evaluation here.]

International Trade Impact Assessment

The provisions of this proposed rule would have little or no impact on trade for U.S. firms doing business in foreign countries and foreign firms doing business in the United States.

Federalism Implications

The regulation proposed herein would not have a substantial direct effect on the States, on the relationship between the national Government and the states, or on the distribution of power and responsibilities among the various levels of government. Therefore, in accordance with Executive Order 12612, it is determined that this proposal would not have sufficient federalism implications to warrant the preparation of a federalism assessment.

Unfunded Mandates Reform Act

Title II of the Unfunded Mandates Reform Act of 1995 (the Act), codified in 2 U.S.C. 1501-1571, requires each Federal agency, to the extent permitted by law, to prepare a written assessment of the effects of any Federal mandate in a proposed or final agency rule that may result in the expenditure by State, local, and tribal governments, in the aggregate, or by the private sector, of $100 million or more (adjusted annually for inflation) in any one year. Section 204(a) of the Act, 2 U.S.C. 1534(a), requires the

Federal agency to develop an effective process to permit timely input by elected officers (or their designees) of State, local, and tribal governments on a proposed "significant intergovernmental mandate." A "significant intergovernmental mandate" under the Act is any provision in a Federal agency regulation that will impose an enforceable duty upon State, local, and tribal governments, in the aggregate, of $100 million (adjusted annually for inflation) in any one year. Section 203 of the Act, 2 U.S.C. 1533, which supplements section 204(a), provides that before establishing any regulatory requirements that might significantly or uniquely affect small governments, the agency shall have developed a plan that, among other things, provides for notice to potentially affected small governments, if any, and for a meaningful and timely opportunity to provide input in the development of regulatory proposals.

This proposed rule does not contain a Federal intergovernmental or private sector mandate that exceeds $100 million in any one year.

Environmental Analysis

FAA Order 1050.1D defines FAA actions that may be categorically excluded from preparation of a National Environmental Policy Act (NEPA) environmental assessment or environmental impact statement. In accordance with FAA Order 1050.1D, appendix 4, paragraph 4(j), this rulemaking qualifies for a categorical exclusion.

Energy Impact

The energy impact of the proposed rule has been assessed in accordance with the Energy Policy and Conservation Act (EPCA) and Public Law 94-163, as amended (42 U.S.C. 6362). It has been determined that it is not a major regulatory action under the provisions of the EPCA.

Regulations Affecting Intrastate Aviation in Alaska

Section 1205 of the FAA Reauthorization Act of 1996 (110 Stat. 3213) requires the Administrator, when modifying regulations in Title 14 of the CFR in a manner affecting intrastate aviation in Alaska, to consider the extent to which Alaska is not served by transportation modes other than aviation, and to establish such regulatory distinctions as he or she considers appropriate. Because this proposed rule would apply to the certification of future designs of transport category airplanes and their subsequent operation, it could, if adopted, affect intrastate aviation in Alaska. The FAA therefore specifically requests comments on whether there is justification for applying the proposed rule differently to intrastate operations in Alaska.

List of Subjects in 14 CFR Part 25:

Aircraft, Aviation safety, Reporting and record keeping requirements

The Proposed Amendment

In consideration of the foregoing, the Federal Aviation Administration proposes to amend part 25 of Title 14, Code of Federal Regulations, as follows:

Part 25 - AIRWORTHINESS STANDARDS: TRANSPORT CATEGORY AIRPLANES

1. The authority citation for Part 25 continues to read as follows:

Authority: 49 U.S.C. 106(g), 40113, 44701-44702, and 44704.

2. Amend § 25.391 by removing the reference to § 25.415 as follows:

§ 25.391 Control surface loads: general.

The control surfaces must be designed for the limit loads resulting from the flight conditions in §§ 25.331, 25.341(a) and (b), 25.349 and 25.351, considering the requirements for__

(a) Loads parallel to hinge line, in § 25.393;

(b) Pilot effort effects, in § 25.397;

(c) Trim tab effects, in § 25.407;

(d) Unsymmetrical loads, in § 25.427; and

(e) Auxiliary aerodynamic surfaces, in § 25.445.

3. Amend paragraph (b) of § 25.395 by removing the reference to § 25.415 and clarifying the reference to the limit loads of paragraph (a) of § 25.395.

§ 25.395 Control System

* * *

(b) The system limit loads of paragraph (a) need not exceed the loads that can be produced by the pilot (or pilots) and by automatic or power devices operating the controls.

4. Revise § 25.415 "Ground gust conditions" to read as follows.

§ 25.415 Ground gust conditions.

(a) The flight control systems and surfaces must be designed for the limit loads generated when the aircraft is subjected to a horizontal 65 knots ground gust from any direction, while taxiing with the controls locked and unlocked and while parked with the controls locked.

(b) The control system and surface loads due to ground gust may be assumed to be static loads and the hinge moments H, in foot pounds, must be computed from the formula,

$H=K\ 1/2\rho_o V_{fps}^2 cS$

where:

K = hinge moment factor for ground gusts derived in paragraph (c) of this paragraph

ρ_o = density of air at sea level = .0023769 (slugs/ft^3) = .0023769 (lb-sec^2/ ft$^{4)}$

V = 65 knots = 109.71 fps relative to the aircraft

S = area of the control surface aft of the hinge line (ft^2)

c = mean aerodynamic chord of the control surface aft of the hinge line (ft)

(c) The hinge moment factor K for ground gusts must be taken from the following table:

	Surface	*K*	Position of controls
	(a) Aileron ----------	0.75	Control column locked or lashed in mid-position.
	(b) Aileron ---------- (c) Elevator---------- (d) Elevator---------- (e) Rudder---------- (f) Rudder----------	*±0.50 *±0.75 *±0.75 0.75 0.75	Ailerons at full throw. (c) Elevator full down. (d) Elevator full up. (e) Rudder in neutral. (f) Rudder at full throw.

- A positive value of *K* indicates a moment tending to depress the surface, while a negative value of *K* indicates a moment tending to raise the surface.

(d) The computed hinge moment of paragraph (b) must be used to determine the limit loads due to ground gust conditions for the control surface. A 1.25 factor on the computed hinge moments must be used in calculating limit control system loads.

(e) Where control system flexibility is such that the rate of load application in the ground gust conditions might produce transient stresses appreciably higher than those corresponding to static loads, in the absence of a rational analysis an additional factor of 1.6 must be applied to the control system loads of paragraph (d) to obtain limit loads. If a rational analysis is used, the additional factor must not be less than 1.20.

(f) For the condition of the control locks engaged, the control surfaces, the control system locks and the parts of the control systems (if any) between the surfaces and the locks must be designed to the respective resultant limit loads. Where control locks are not provided then the control surfaces, the control system stops nearest the surfaces, and the parts of the control systems (if any) between the surfaces and the stops must be designed to the resultant limit loads. If the control system design is such as to allow any part of the

control system to impact with the stops due to flexibility, then the resultant impact loads must be taken into account in deriving the limit loads due to ground gust.

(g) For the condition of taxiing with the control locks disengaged, the following apply:

(1) The control surfaces, the control system stops nearest the surfaces and the parts of the control systems (if any) between the surfaces and the stops must be designed to the resultant limit loads.

(2) The parts of the control systems between the stops nearest the surfaces and the cockpit controls must be designed to the resultant limit loads, except that the parts of the control system where loads are eventually reacted by the pilot need not exceed:

(i) The loads corresponding to the maximum pilot loads in § 25.397 (c) for each pilot alone; or

(ii) 0.75 times these maximum loads for each pilot when the pilot forces are applied in the same direction.

Issued in _____on

Aircraft Certification Service

Draft AC not for Public Distribution

U.S. Department
of Transportation
**Federal Aviation
Administration**

Advisory Circular

GROUND GUST CONDITIONS

Date: 26 September, 2000
Initiated by: ANM-110

AC No. 25.415-1
Change:

1. PURPOSE. This advisory circular (AC) sets forth acceptable methods of compliance with the provisions of part 25 of the Federal Aviation Regulations (FAR) dealing with the certification requirements for ground conditions. Guidance information is provided for showing compliance with § 25.415 of the FAR, relating to structural design of the control surfaces and systems while taxiing with control locks engaged and disengaged and when parked with control locks engaged. Other methods of compliance with the requirements may be acceptable.

2. RELATED FAR SECTIONS. The contents of this AC are considered by the Federal Aviation Administration (FAA) in determining compliance with § 25.415 of the FAR.

3. BACKGROUND.

a. The requirement to consider the effects of ground gusts has been applied to transport airplane since 1950. The purpose of the requirement was to protect the flight control system from excessive peak ground wind loads while the airplane is parked or while taxiing downwind. For developing the original regulation, the control surface load distribution was considered to be triangular with the peak at the trailing edge representing reversed flow over the control surface. This assumption, along with assumptions about the wind approach angle and typical control surface geometries were developed into a table of hinge moment factors and set forth in the regulation. These hinge moment factors have been carried forward to the existing table in section § 25.415. The maximum design wind speed was originally set at 88 feet per second (52 knots) under the presumption that higher speeds were predictable storm conditions and the aircraft owner could take additional precautions beyond engaging the standard gust locks.

b. Amendment 25-91 incorporated a new condition into the FAR for jacking and tie down loads which was similar to the existing Joint Aviation Requirement 25.519. Those conditions required consideration of the airplane in a moored or jacked condition in wind speeds up to 65 knots. In order to be consistent in the treatment of ground winds, § 25.415, concerning ground gust conditions on control surfaces, was increased to 65 knots at the same time.

c. There have been several incidents and accidents caused by hidden damage that had previously occurred in ground gust conditions. Although many of these events were for airplanes that had used the lower wind speeds from the earlier rules, analysis indicates that the most significant contributor to the damage was the dynamic load effect. The dynamic effects were most significant for control system designs in which the gust locks were designed to engage the control system at locations far from the control surface horn. Based on these events, Amendment 25-XX, in addition to clarifying the rule, added additional factors for use in those portions of the system and surface that could be affected by dynamic effects.

d. The flight control system and surface loads prescribed by section 25.415 are limit loads based on a peak wind speed of 65 knots EAS. In operation, the peak wind speed would most often be caused by an incremental fluctuation in velocity imposed on top of a less rapidly changing mean wind speed. Therefore, an appropriate peak wind speed limitation should be reflected in the applicable documents, when there is a potential risk of structural damage.

4. COMPLIANCE.

a. The ground gust requirements take into account the conditions of the airplane parked with controls locked, and taxiing with controls either locked or unlocked. In either of the locked conditions the control surface loads are assumed to be reacted at the control system locks. In the unlocked condition the pilot is assumed to be at the controls and the controls are assumed to be powered, if applicable. In the latter condition, the control surface loads are assumed to be reacted, if necessary, at the cockpit controls by the pilot(s) up to the limits of the maximum pilot forces and torques given in § 25.397(c).

b. Where loads are eventually reacted at the cockpit controls, the loads in those parts of the control system between the control system stops nearest the control surfaces and the cockpit controls need not exceed those that would result from the application of the specified maximum pilot effort effects. However, higher loads can be reacted by the control system stops. Those parts of the control system from the control surfaces to the control system stops nearest the surfaces should be designed to the resultant limit loads regardless of pilot effort limitations. Similarly, pilot effort limitations would not apply to parts of control systems where the loads are not eventually reacted at the cockpit controls, for example an aileron control system where the right hand side aileron loads are reacted by the left hand side aileron, without participation by the pilot(s).

c. In either the taxiing condition (controls locked or unlocked) or the parked condition (controls locked), if the control system flexibility is such that the rate of load application in the ground gust conditions might produce transient stresses appreciably higher than those corresponding to static loads, the effects of this rate of application are required to be considered. Manually powered control systems and control systems where the gust lock is located remotely from the control surface are examples of designs that might fall in this category. In such cases the control system loads are required by § 25.415(e) to be increased by an additional factor over the standard factor of 1.25.

AIR LINE PILOTS ASSOCIATION, INTERNATIONAL

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July 9, 2001

Pratt & Whitney
Attn: Craig R. Bolt M/S 162-24
400 Main Street
East Hartford, CT 06108

PW6000 Chief Systems Engineer-Validation and Certification
M/S 162-14

Dear Mr. Bolt:

The Air Line Pilots Association, International (ALPA) does not concur with the Loads and Dynamics Harmonization Working Group (L&DHWG) report presented to TAEIG at the June 26-27, 2001 meeting. We believe that operational considerations have not been appropriately included in determining certification standards. As noted in the report, ALPA previously commented that, for an aircraft with reversible flight controls, developing a design standard predicated on the assumption that pilots would physically restrain the controls during ground operation without a specific requirement to do so was not operationally realistic. The current HWG report has no provision to either fully account for reversible controls being unrestrained by the pilot(s) or a requirement that pilots be made aware of the design assumption that the controls would be restrained during ground operation.

The report gives reasons for not making the provisions noted above, saying in part, "The L&DHWG does not feel that it is reasonable to operate an aircraft with manual control systems in design ground gust conditions with the pilot not constraining the control systems. This is supported by the FAA Flying Handbook FAA-H-8083-3 Chapter 2 for Ground Operations". This makes it clear that the certification standard relies on pilot actions to prevent control system damage. However, the proposed rule contains no provision that would ensure this design assumption becomes a part of the operational procedures for the airplane. In addition, we do not believe the citation of FAA-H 8083-3 is valid. That handbook, the re-titled Advisory Circular 61-21, is intended for pilot training in general aviation aircraft. Although the basic principles of flight remain the same regardless of aircraft size or intended use, the referenced document is clearly not intended to reflect the size, sophistication of systems, or the cockpit workload of multi-pilot aircraft in air carrier operations certified under Part 25. Some aircraft in air carrier service today (e.g. DC-9 series aircraft) have reversible controls that pilots are not able to keep from moving to the stops when blown by the wind. Irreversible control designs do not blow against the stops so pilot restraint is not required. Thus, most aircraft in airline service today are either reversible control designs in which pilot input is ineffective or irreversible control designs where pilot input is not required - further basis for pilots not knowing they are required by a particular design to resist control movement or risk control system damage and perhaps failure.

ALPA is concerned that this is an additional example of inconsistency between a certification rule and operation of the aircraft. If the rule is promulgated as proposed, we do not see how an FAA operations inspector can insure a specific carrier's aircraft operating procedure meets the needs of certification if the assumptions used in certification are not communicated to the inspector and the carrier.

Thank you for the opportunity to comment.

Sincerely,

Jim Bettcher

Captain Jim Bettcher
Director, Aircraft Certification Program/at

JRB:ak

cc: J. Wallace